

# INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

## (PCT Article 36 and Rule 70)

Applicant's or agent's file reference -?-	<b>FOR FURTHER ACTION</b>	
See Form PCT/PEA/416		
International application No. PCT/B2004/001738	International filing date (day/month/year) 27.05.2004	Priority date (day/month/year) 15.08.2003
International Patent Classification (IPC) or national classification and IPC G21C13/024, G21C5/10, B65D90/12		
Applicant PEBBLE BED MODULAR REACTOR... et al. /		

<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet. /</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> (<i>sent to the applicant and to the International Bureau</i>) a total of 5 sheets, as follows:</p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</li> <li><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</li> </ul> <p>b. <input type="checkbox"/> (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)), containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>	
<p>4. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Box No. I Basis of the opinion</li> <li><input type="checkbox"/> Box No. II Priority</li> <li><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</li> <li><input type="checkbox"/> Box No. IV Lack of unity of invention</li> <li><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</li> <li><input type="checkbox"/> Box No. VI Certain documents cited</li> <li><input checked="" type="checkbox"/> Box No. VII Certain defects in the international application</li> <li><input checked="" type="checkbox"/> Box No. VIII Certain observations on the international application</li> </ul>	

Date of submission of the demand 31.05.2005 /	Date of completion of this report 06.02.2006
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**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
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**Box No. I Basis of the report**

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
  - This report is based on translations from the original language into the following language, which is the language of a translation furnished for the purposes of:
    - international search (under Rules 12.3 and 23.1(b))
    - publication of the international application (under Rule 12.4)
    - international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

**Description, Pages**

1-18 as originally filed

**Claims, Numbers**

1-25 filed with telefax on 19.01.2006

**Drawings, Sheets**

19-99 as originally filed

- a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3.  The amendments have resulted in the cancellation of:
  - the description, pages
  - the claims, Nos.
  - the drawings, sheets/figs
  - the sequence listing (*specify*):
  - any table(s) related to sequence listing (*specify*):
4.  This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
  - the description, pages
  - the claims, Nos.
  - the drawings, sheets/figs
  - the sequence listing (*specify*):
  - any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Yes: Claims	1-25
	No: Claims	
Inventive step (IS)	Yes: Claims	1-25
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-25
	No: Claims	

**2. Citations and explanations (Rule 70.7):**

**see separate sheet**

**Box No. VII Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:

**see separate sheet**

**Box No. VIII Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

**see separate sheet**

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**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Reference is made to the following documents which were cited in the International Search Report from 17-03-2005:**

D1 = GB889758

D2 = WO8204092

D3 = US4379119

D4 = GB1080405

D5 = US4008757

**2. Conformity with Article 33 PCT**

Subject to the observations made under section VIII the present application appears to satisfy the criterion set forth in Article 33 PCT because the subject-matter of claim 1 - 25 is novel (Article 33(2) PCT), involves an inventive step Article 33(3) PCT and is industrially applicable (Article 33(4) PCT).

The invention relates to a method and an arrangement of supporting a vessel in the form of a core barrel of a high temperature gas cooled reactor housed within a reactor pressure vessel, the arrangement comprising a single vertical support centrally positioned about the axis of the barrel and a lateral support means.

Such an arrangement is disclosed in D1 (see figure 1 and 2).

The invention is characterised in that the vertical support comprises upper and lower support members which are relatively displaceable and that the lateral support means is positioned at the upper end of the core barrel and includes a set of inner and outer lateral support members connected to the core barrel and the reactor pressure vessel respectively and a roller element sandwiched between the inner and outer members.

Such an arrangement can accommodate thermal vertical and horizontal expansions of the core barrel without subjecting it to exceptional stresses.

In none of the cited documents such an arrangement is shown or can be obviously

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deducted therefrom.

In D1 the upper and lower support members of the vertical support are not displaceable and the lateral support is not positioned at the upper end of the core barrel and do not include roller members.

D2 describes a vibration damping arrangement whereby an inner housing is suspended in an outer housing by a plurality of identical spring-damper units with a sphere as a roller element and particularly aims to accommodate fast acceleration transients. There is no single central vertical support in combination with a lateral support located at an upper end. Therefore, this arrangement is different in concept to the invention which provides quasi static support for heavy large vessels with slow expansion and contraction.

D3 shows a lateral friction damper (ref. 4 in fig. 4) positioned at two vertical levels for pushing support frames towards the fuel assemblies in case of vibration thereof. There is no core barrel in form of a vessel, but merely in form of separate frames and shielding plates.

D4 describes a construction of a core support plate for supporting and locating fuel assemblies. No core barrel and no lateral support means are shown.

D5 shows an arrangement for supporting large pressure vessels in a concrete well with a central sliding vertical support and a plurality of lateral supports in the form of shock absorbers distributed along the side wall of the vessel. There are no details of the lateral support.

The combination of any of the documents D1-D5 would not result in a support arrangement as claimed in claim 1 and 25 and would not be adapted to solve the specific problems (thermal expansion) related to high temperature gas cooled reactors.

Claims 2-24 are all directly or indirectly dependent on claim 1 and therefore also new and inventive.

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**Re Item VII**

**Certain defects in the international application**

Independent claims 1 and 25 are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (D1) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

**Re Item VIII**

**Certain observations on the international application**

In claim 1 and 25 the term *single vertical support* although essential for the invention, appears to be in contradiction with the description and figures where clearly three vertical supports are described and shown i.e. vertical support 16 (fig. 1,2), vertical support 130 (fig. 3,4) and vertical support (fig. 14-16 made up of annular skirt (302) with slots (306) cooperating with protrusions (304) of ring (134). This contradiction leads to unclarity of claim 1 and 25, thus infringing Article 6 PCT.

Also, in claim 25 claiming *the lateral support* being at the upper end of the core barrel, although essential for the invention, appears to be in contradiction with the description page 17, middle paragraph, where the lateral support is defined as lower lateral support. Claim 25 is therefore unclear and/or not supported by the description (Article 6 PCT). From the description it can be understood that the lateral support comprises an upper (as shown in the embodiments of fig. 7-12) and a lower lateral support (beams 316 received between support member 48 and shims 318 etc.).

As can be seen from the description on page 14, second paragraph the inclined surfaces of the lateral support members appear essential for the embodiment of the invention. This feature (now in claim 12) should have been comprised in claim 1 and 25 respectively. Equally it would appear essential that the lateral support means is located at the upper end of the core barrel (see page 10, second paragraph). This feature should have been included into claim 1.

## CLAIMS

1. A support arrangement characterised in that it includes  
a vessel in the form of a core barrel (14) of a high temperature gas  
cooled reactor (10, 200) which is housed within a reactor pressure vessel  
(12), the core barrel (14) being generally cylindrical in shape and having an  
axis which extends generally vertically;  
a single vertical support (16) for supporting the weight of the core barrel  
(14), the vertical support (16) including upper and lower support members (44,  
46) which are connected respectively to the core barrel (14) and the reactor  
pressure vessel (12) between which the vertical loads are transmitted, the  
upper and lower support members (44, 46) which are relatively displaceable  
defining oppositely disposed contact surfaces (50, 60) which are centrally  
positioned about the axis; and  
lateral support means (18) for providing support to the core barrel (14);  
the lateral support means including a plurality of circumferentially spaced  
upper lateral supports (76) each of which includes a set of inner and outer  
lateral support members (78, 80) connected to the core barrel (14) and the  
reactor pressure vessel (12), respectively, and a roller element (86)  
sandwiched between the inner and outer upper lateral support members (78,  
80).
2. A support arrangement as claimed in claim 1, in which at least one of  
the contact surfaces is curved (50, 60).
3. A support arrangement as claimed in claim 2, in which both of the  
contact surfaces (50, 60) are curved.
4. A support arrangement as claimed in claim 3, in which the upper  
support member (44) defines a concave contact surface (50), the lower  
support member (46) defining an oppositely disposed convex contact surface  
(60).

5. A support arrangement as claimed in claim 4, in which the radius of the convex contact surface (60) is smaller than that of the concave contact surface (50).
6. A support arrangement as claimed in claim 1, in which the vertical support (16) includes an intermediate member (202) interposed between the upper and lower support members (44, 46).
7. A support member as claimed in claim 6, in which the intermediate member (202) defines upper and lower contact surfaces (204, 206) which cooperate, respectively, with complementary contact surfaces (208, 210) of the upper and lower support members (44, 46).
8. A support arrangement as claimed in claim 7, in which the contact surfaces (204, 206) of the intermediate member (202) are convex with the complementary contact surfaces (208, 210) of the upper and lower support members (44, 46) being concave.
9. A support arrangement as claimed in claim 8, in which each convex contact surface (204, 206) has a radius which is smaller than that of the complementary concave contact surface (208, 210).
10. A support arrangement as claimed in any one of the preceding claims, in which the upper lateral supports (76) are positioned to support the core barrel (14) laterally at or towards the upper end thereof.
11. A support arrangement as claimed in any one of the preceding claims, in which the roller (86) includes at least one gear wheel (92) having teeth, and at least one of the inner and outer upper lateral support members (78, 80) is provided with teeth (98) which are complementary to those on the gear wheel (92) to ensure that relative displacement between the roller (86) and complementary bearing surfaces (82, 84) of the inner and outer upper lateral support members (78, 80) is by rolling.

12. A support arrangement as claimed in claim 11, in which the bearing surfaces (82, 84) of the inner and outer upper lateral support members (78, 80) are inclined.

13. A support arrangement as claimed in any one of the preceding claims, in which at least one of the inner and outer upper lateral support members (78, 80) of each set is mounted on a resiliently deformable support (104).

14. A support arrangement as claimed in claim 13, in which each outer upper lateral support member (80) is mounted on a resiliently deformable support (104) which, in turn, is mounted on an upper support ring (72) secured to the reactor pressure vessel (12).

15. A support arrangement as claimed in claim 14, in which the resiliently deformable support (104) includes a pair of support posts (106) connected to the upper support ring (72) at spaced apart positions and an elastically deformable guide beam (108) which extends between the support posts (106) and on which the outer upper lateral support member (80) is mounted.

16. A support arrangement as claimed in claim 15, in which the position of the guide beam (108) is adjustable thereby permitting the relative positions of the inner and outer upper lateral support members (78, 80) to be adjusted.

17. A support arrangement as claimed in any one of the preceding claims, in which the lateral support means (18) includes a plurality of circumferentially spaced lower lateral supports (312) positioned to provide lateral support to the core barrel (14) adjacent to a lower end thereof.

18. A support arrangement as claimed in claim 17, in which each lower lateral support includes an elastically deformable locating element (312) extending radially between inner and outer receiving formations (314, 316) to transmit lateral loads between the core barrel (14) and the reactor pressure vessel (12).

19. A support arrangement as claimed in claim 18, in which the inner receiving formations (314) are provided on the upper support member (44) and the outer receiving formations (316) are protrusions (304, 318) which protrude radially inwardly from a lower support ring (134) secured to the reactor pressure vessel (12).
20. A support arrangement as claimed in any one of the preceding claims, which includes auxiliary support means (130, 132) for providing support to the core barrel (14) within the reactor pressure vessel when subjected to loads in excess of normal operational loads such as would be experienced during a seismic event.
21. A support arrangement as claimed in claim 20, in which the upper support member (44) includes a central member (48) which extends downwardly from the bottom (30) of the core barrel (14) and a plurality of angularly spaced support beams (54) connected to the bottom (30) of the core barrel (14) and to the central member (48) and extending radially outwardly from the central member (48), the auxiliary support means including a lower auxiliary support (130) including a plurality of circumferentially spaced radially inwardly facing slots (138) in which radially outer ends of the support beams (54) are receivable with clearance.
22. A support arrangement as claimed in claim 21, in which the slots (138) are defined on a radially inner surface of a lower support ring (134) secured to the reactor pressure vessel (12).
23. A support arrangement as claimed in claim 20, in which the upper support member (44) includes a central member (48) which extends downwardly from a bottom (30) of the core barrel (14) and a plurality of angularly spaced support beams (54) connected to the bottom (30) of the core barrel (14) and to the central member (48) and extending radially outwardly from the central member (48) to an annular skirt (302) which depends from the core barrel (14), the auxiliary support means including a lower auxiliary support (130) which includes a plurality of circumferentially spaced protrusions

(304) which protrude radially inwardly from a lower support ring (134) secured to the reactor pressure vessel and which are received with clearance in complementary slots (306) in the skirt (302).

24. A support arrangement as claimed in any one of claims 20 to 23, inclusive, in which the auxiliary support means includes an upper auxiliary support (132) comprising a plurality of circumferentially spaced ribs (140) connected to and protruding outwardly from the core barrel (14) and complementary slots (142) provided in and opening out of a radially inner surface of the upper support ring (72) within which slots (142) end portions of the ribs (140) are receivable with clearance.

25. A method of supporting a vessel in the form of a core barrel (14) of a high temperature gas cooled nuclear reactor (10, 200) which is housed within a reactor pressure vessel (12), the core barrel (14) being generally cylindrical in shape and having an axis which extends generally vertically, the method being characterised in that it includes

transmitting the weight of the core barrel (14) and its contents to the reactor pressure vessel (12) through a single vertical support (16); and

transmitting lateral loads between the core barrel (14) and the reactor pressure vessel (12) through a lateral support (18) which is positioned at or adjacent an upper end of the core barrel (14) and which includes a plurality of circumferentially spaced upper lateral supports (76) each of which includes a set of inner and outer lateral support members (78, 80) connected to the core barrel (14) and the reactor pressure vessel (12), respectively, and a roller element (86) sandwiched between the inner and outer upper lateral support members (78, 80).

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